Situated Questions and Answers

Responding to Library Users with QR Codes

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Reference & User Services Quarterly, vol. 51, no. 1, pp. 60–69

This study employs the case study approach to examine a QR code pilot implemented at the University of Colorado at Boulder (CUB) Libraries in Fall 2010 using Microsoft Tag. Through observations and experiences gathered during the pilot, the study seeks to identify effective implementation strategies while also revealing benefits and challenges to be considered when managing similar QR code projects in academic library settings. The findings support continued investigation of QR codes to respond to the growing mobile device trends among college students and as a means to bridge virtual and physical library services, resources, and tools. Through the CUB pilot description, interested librarians will gain perspectives on implementation, benefits, and challenges, which will prove useful in pursuing similar projects.

From June 2000 to June 2010, the International Association for the Wireless Telecommunications Industry reported that cell phone ownership in US households grew 59 percent.[1] As ownership has expanded so too have the ways in which individuals use these devices in their daily lives. The Pew Internet Trust Mobile Access Report, 2010, found that 40 percent of adults with cell phones use them for non-voice related tasks, such as taking pictures, text messaging, Internet access, e-mailing, video creation, and instant messaging.[2] The Nielsen Company's 2010 *Mobile Youth around the World* report found that "young people around the world are more immersed in mobile technology than any previous generation."[3] Of United States mobile device owners age 15–24, 83 percent use advanced data features, such as Internet access.[4]

Given these findings, it seems likely that accessing the Internet via a mobile device rather than a traditional computer will only become more widespread. Yet mobile devices are not miniature PCs.[5] The specific characteristics of mobile devices, such as small screens and keyboards, data plans, seamless connectivity and mobility mean that users are creating new reasons and ways to seek information. It is thus vitally important that libraries, as information providers, can meet the new expectations to adapt to and engage with the new information retrieval practices of library users.

One way that libraries can respond is to capitalize on the ubiquity and instant connectivity of mobile devices to link the virtual and the physical library. As library users have become increasingly dependent on electronic access, librarians have worked to enhance their virtual presence with services such as instant

messaging, with learning tools such as online research guides, and with research resources such as electronic databases. While these services are indeed valuable, the physical library remains an essential factor in supporting the research and learning needs of users. Librarians exhibit commitment to the physical space through the renewed emphasis on the library as place in the development of learning commons.[6] However, rather than approaching the virtual and physical library as distinct efforts, greater service enhancement might be achieved by building a bridge between the virtual and physical library for users. QR codes present one method of doing so by leveraging near extensive mobile device ownership.

QR Codes, or quick response codes, are two-dimensional barcodes, which can be read by a scanner found on Internet enabled mobile devices. Previously, one dimensional line barcodes enabled quick and efficient connection between physical objects and identifying details, as evidenced by library circulation systems, store and industry inventory, and mailing or shipping systems. QR codes, developed by Denso Wave in 1994, build on the functionality of these original barcodes but far extend the possibilities and application.[7] Not only is the amount of information stored within a QR code much greater, but the type of information has also expanded to include text, URLs, phone numbers and other data. Though the drive to develop these codes came from industry, the use of QR codes in alternate settings is growing in the United States. For example, one might notice a QR code on museum signage detailing an artist's work; one might notice a QR code on a product label; or one might notice the inclusion of QR codes in newspaper or magazine publications.

The process of creating a QR code is easy due to the prevalence of free QR code generators such as Microsoft Tag, Kaywa, icandy, Nokia and Deliver. These services take user supplied data and produce a QR code rendered in a variety of image file formats such as jpeg, pdf, tiff, png or gif. The image may then be placed on publications, business cards, marketing material, or most surfaces (print or electronic). Properly equipped devices, such as smart phones or web-enabled phones, can then use inbuilt scanning capabilities or a downloaded application (app) to scan and interpret the code, which points the viewer to specified data. Due to the prevalence of mobile devices, many people, including library users, have QR code readers in hand.

Accordingly, in Fall 2010 a QR code pilot was launched at the University of Colorado at Boulder (CUB) Libraries to explore whether QR codes could provide a conduit between physical spaces, virtual services, and users. The rationale for the project was based around two ideas. First, at CUB, mobile devices play an increasingly key role on campus. According to a 2008 study conducted by the CUB *Arts and Sciences Support of Education through Technology* (ASSETT) program, nine out of ten CUB students use cell phones on a daily basis.[8] While figures on campus smart phone ownership are not currently available, the authors assumed a local reflection of national trends and projected increase in smart phone ownership. Recognizing this trend, the Information Technology Department is exploring communication methods to reach the campus audience through mobile devices. CUB's commitment to these new communication opportunities is evidenced in the CUB Information Technology Department's strategic plan which includes mobile computing goals and mobile optimization of web delivered content such as campus maps, campus news, RSS feeds, bus schedules, computer lab seating, as well as campus calendars and events.[9] These trends supported the potential popularity of QR codes to current and future students, thus providing one impetus for the pilot. Observed issues at the library provided the second impetus. The main campus library is constantly welcoming new students yet also presents a complex building structure that is difficult to navigate, not an uncommon situation for campus libraries across the country. In the last few years, the building and the services therein have undergone numerous renovations. Library employees are constantly seeking methods to communicate these changes, respond to immediate and specific user needs, and to promote library services.

Given the prevalence of mobile device ownership and the known local issues, two reference librarians, members of the Research and Instruction Department, were inspired to investigate the new communication solutions made possible by QR codes. The low cost and innovative technology allowed flexibility to meet user needs at locations not in close proximity to service points or help resources. Furthermore, the librarians could designate the precise resources, services, and tools to be delivered in spaces where users might encounter specific information needs. While there were numerous possibilities, there remained a number of questions about implementation and user response. Therefore, the librarians chose to implement a pilot that would explore the viability of larger scale implementation and would reveal initial user reactions. The core objectives of this case study are to share the implementation steps and logistics employed in the CUB pilot. The first section will situate QR codes in libraries today, while the second will cover the implementation of the project, including content selection as well as QR code generation and placement. The last section will cover lessons learned and include statistics and a description of the considerations and challenges warranting more attention. Through the unique CUB experiences and observations, libraries interested in similar projects will gain insights into QR code uses in academic libraries.

LITERATURE REVIEW

It is clear that the mobile web and mobile devices are starting to play a growing role in the provision of many library services. Despite the initial lag in establishing even a mobile university webpage, several librarians have already published practical and general introductions to mobile services.[10] While a complete review of mobile web literature is beyond the scope of this literature review, there are many good summaries. Jason Griffey has produced a simple yet thorough introduction to a library looking to expand into simple or

extensive mobile web projects.[11] This practical guide is reinforced by Jim Hahn's 2008 article, which includes a literature review of mobile projects.[12] Finally, an expanding source is M-Libraries, which is part of Meredith Farkas' Lib Success wiki.[13] This serves as an up to date record of mobile literature and mobile projects in libraries. While the literature about mobile projects is obviously growing rapidly, it is clear, however, that many mobile web studies are tech-centric, focusing on what the technology can achieve rather than changes in user behavior and focus.

In an insightful piece, Aldrich cautions against the tech-centric approach by looking comparatively at how users and designers approach information sharing and gathering on the mobile web versus the full web.[14] For him, using the full web is more akin to an analog task; a contextual, linear process with few pauses. An example of this would be surfing the Internet. While one might visit a specific site, it is easy to move from site to site, browsing for related information. Using the mobile web, however, is more of a digital task; a discontinuous, decontextualized action that could be spread across people, places and time. An example of this is using a software application (app) on a smart phone. An app "condenses information into prepackaged forms" creating a specific tool for a specific information need.[15] As users become more accustomed to the efficient information gathering app model, they become accustomed to reducing "the cognitive load associated with finding and processing information."[16] In other words, users expect to access the mobile web for a short period to obtain specific information or to perform specific tasks. This paradigm shift in information use is also reflected in current literature on signage. Char Booth implemented a point of need information kiosk at Ohio University in response to the "massive paradigm shift in information use patterns and a consequent repositioning of library-related expectations and needs" as well as the intimidating size and range of resources found in the physical library.[17] She perceived that libraries would no longer be able to rely on static service points, and advocated a move toward providing service "where, when, and how users desire it."[18] These findings provide part of the theoretical underpinnings of the concepts behind QR codes.

QR Codes literature forms a small part of the mobile web. Despite the popularity of QR Codes in Japan, adoption of mobile barcodes, and consequently literature describing their use, has been limited in the English-speaking world. While the long term use and adoption of QR codes remains to be seen, more groups in business and academia have started to explore how QR codes could be used.

Much of the early English language academic research has come from the United Kingdom, and specifically from the University of Huddersfield and the University of Bath. For a general overview, Andrew Ramsden provides a preliminary analysis of the potential of QR Codes in academia while Andrew Walsh is the first to examine QR feasibility in a library setting.[19] In the United States, Jeff Wisniewski provides a thoughtful introduction to QR Codes for academic libraries, and Paula MacKinnon and Cathy Sanford's paper on QR code implementation serves public libraries.[20] Within this literature, library services promoted using QR Codes fall into several intersecting categories. These include using QR Codes to bridge the physical and the virtual world; to provide information at the point of need; and to aid assessment.

The current separation of the online and the physical library and the desire to unite the two drives much of the QR literature. Wisniewski goes as far as pointing out that there is still a certain digital divide between online and physical resources, which contributes to a lower quality user experience of the library. For him, it is essential that librarians leverage "the insights we've gained from our experiences in our online world, as well as with our electronic products and services, in order to provide users a high-quality, low-friction experience."[21] Walsh tends to agree with this, stating more explicitly that while libraries have created numerous online help resources, there is often "minimal embedding of these online resources within the physical world" to help users navigate the physical world competently.[22] He further states that where help is provided it tends to be very generic, e.g. one service point/help desk.

Conversation about the convergence of the online and the physical world dates back to the early nineteen nineties. An early proponent, George Fitzmaurice predicted that small portable devices would eventually provide a "bridge . . . between the computer synthesized information spaces and physical objects," and that by using retrieval cues to associate electronic information with physical objects, librarians would be able to provide situated information spaces that help "understanding of the organization of the space and . . . improve user orientation."[23] More recently and more prosaically, Wisniewski highlights that linking physical and online objects makes a great deal of marketing and business sense. He points out that librarians have spent a great deal of time, effort and money to create online spaces and that librarians should leverage "our electronic universes in our physical spaces" to maximize ROI.[24]

There are many ways to link the physical and virtual library. The most popular use of QR codes in the literature is to link physical elements of the library with their electronic counterparts. For example, the University of Huddersfield uses QR codes to link current periodicals with electronic versions, as well as providing online tutorials at service points such as copiers and copy card machines.[25] The Technical University of Catalonia employs QR codes to store computer log in information while Contra Costa Library applies QR codes to link popular book collections to readers' advisory materials online.[26] Wisniewski (2010) mentions the possibility of embedding QR codes in books that link to the renewal function of the catalog.[27]

The use of QR codes on physical locations outside the library is also growing. Miquel Codina Vila and Wisniewski mention including QR codes on publicity posters to allow patrons to link seamlessly to the event details or further information such as video and audio.[28] Wisniewski and Ramsden talk of using QR codes as a business card, to enable patrons

to store librarian contact details, for example.[29] Wisniewski also suggests providing a quick "snap to download" link to a library app.[30] Contra Costa Library is the most advanced in its use of QR codes on public transport systems to allow patrons to download audiobooks.[31]

Linking from the library's electronic resources to the physical collection is less often mentioned, presumably because it is assumed that patrons will be using their phone to navigate the web. However, depending on the level of mobile web involvement in a library, this feature could be useful. An example of a successful electronic to physical application comes from the University of Bath, which has embedded QR codes in the library catalog, enabling students to store details and locations of library materials for their visit to the library.[32]

The business community has, like librarians, been quick to appreciate potential benefits of using QR codes. Articles from public relations, banking, real estate and publishing professionals provide insight into motives for adopting QR codes though few authors provide concrete examples of use-scenarios or systematic analysis of use statistics. Marketing is the biggest draw for business functionality and the QR code is posited as solving many issues that are also seen in libraries. For Lehan, the QR code eliminates lagtime between "consumer awareness and any subsequent action," while for Simmons, QR codes can help the marketer connect directly with the public "whose attention is becoming increasingly fragmented."[33] For Dou and Li, the advantage lies in the fact that QR codes are less intrusive as a marketing technique.[34] Providing customers with extended information, or creative engagement with brands is another strong motive for adopting QR codes in business while Tolliver-Nigro mentions the financial benefits, which "can help advertisers get more from their investment in print advertising."[35] Predictably, business literature is heavily focused on the importance of consumer statistics; who is scanning barcodes and where and when are they scanning them. Finally, in a thoughtful article that is directly relevant to libraries, Tolliver- Nigro underlines that any usage of barcodes should be "evaluated and deployed as part of larger customer marketing and relationship strategies" because the purpose of using QR codes is to get people to respond to the marketing rather than the QR code.[36]

Notwithstanding, the literature reveals that there are many potential pitfalls involved with using QR codes. The first major potential drawback is lack of patron awareness about the codes. Andrew Ramsden and Lindsay Jordan conducted a survey of students at the University of Bath in 2008 and found that only 12.6 percent of students were familiar with QR codes. However, they also found that 92 percent of students at the University of Bath owned a phone that could access QR codes, which indicated that the adoption of the new technology was realistic.[37] A follow up survey in 2009 at the University of Huddersfield showed that before the library's extensive promotion of QR Codes only 8 percent of respondents were familiar with QR codes. However after one term of using QR codes in the library, this number increased to 22 percent.[38] Therefore, although there is currently low usage and recognition of QR codes on university campuses, it seems that there is a great deal of potential for more widespread use. Second, a related potential drawback is whether patrons have the necessary QR code reader on their phone.[39] In Ramsden and Jordan's 2008 survey, 80 percent of respondents did not know whether their phone had a QR code app installed.[40] These figures seem likely to change, however, as major manufacturers incorporate QR readers as standard on phones.

Ramsden also draws attention to a third possible drawback to QR codes, which is the potential exclusion of disabled and non-cell phone using patrons. He highlights that visually and mobility impaired students may have problems accessing and using QR Codes due to the positioning of the codes, and the smaller screen of the mobile device. Furthermore, he warns that students with autism and dyslexia may experience trouble with QR Codes that "do not include any meaning or signpost the outcome of the activity when you look at them."[41] He recommends that practice guidelines and thoughtful placing of QR codes should overcome many of these difficulties. Ramsden and Jordan additionally mention concerns about "equitable access," and indicate that alternatives to QR codes would need to be made available for non cell phone/smartphone owning patrons.[42] Related to this, Walsh raises the potential pitfall of data charges. Many smartphone calling plans do not include data and potential users may be alienated by the cost involved to access QR Code information.[43] Both Walsh and Ramsden predict that these problems will become less important, however, as mobile devices and mobile web access become more commonplace.[44]

In sum, the literature review revealed that due to the immaturity of the technology, there was a severe lack of evidence-based studies that examined patron usage of QR codes. While Walsh provided preliminary usage statistics for QR codes that linked to videos and electronic resources, he was unable to fully test patron usage in his 2009 study.[45] Furthermore, there had been little evaluation of providing information to bridge the gap between the digital and physical worlds, nor at a point of need basis. This provided a further impetus for this study.

IMPLEMENTATION

Selection of a QR Code Generator

At the time of choosing a QR code generator for the project, the choice lay between selecting Denso Wave's generic 2D barcode, which could be generated by a variety of free web programs and was supported by Google, and Microsoft's High Capacity Color Barcode, which was generated through the Microsoft Tag program. While the confidence inspired by Google's contribution to the mobile web made the generic QR code seem like an attractive option, Microsoft's Tag program included a sophisticated analytics system, which allowed the classification of tags, the creation of reports and a simple way to administer the barcodes. Despite initial concerns about

the future cost of the program (at present it is free), the CUB librarians chose Microsoft Tag for the statistical functionality. Microsoft Tag integrates fully with the Windows Mobile, BlackBerry, Java, Android, Symbian S60, iPhone and Java ME platforms, although users do need to download the tag app.

CONTENT: SITUATED QUESTIONS AND ANSWERS

After choosing the appropriate QR code generator, the librarians focused on selecting the most relevant content to be communicated with barcodes. Based on perceptions of common student needs and the ability to respond with QR code communicated information, they selected a few core issues on which to focus: way finding, technology operational needs, and librarian contact.

Difficulty navigating the library is an issue often communicated by CUB Library users. There are five main floors in Norlin, the main campus library, with several mezzanines. The main service points are a commons desk, research desk, and circulation desk located on the first and second floors. Library user Internet access is available from workstations found predominantly on the first and second floors supplemented by laptop checkout. There are several stack locations in the building including Norlin Stacks (floors 3a–3c), Government Publications Stacks (floors 3 and basement), Science Stacks (floors 1a, 1b, 2), Art and Architecture (floor 2), East Asian Collection (floor 2 and basement), Central Reference (floor 2). One may access floors 1–3 via elevator or stairs from the east side of the building, while access to floors 1–5 is only available on the building's west side. The stack areas and several study areas are largely void of Internet capable workstations and therefore access to tools such as the catalog. Additionally, because of the lack of proximity to service points, users are required to navigate floors to seek librarian assistance. Placing QR codes in these previously disconnected spaces responded directly to user described navigation difficulties.

A number of user technology tools are available throughout the library including scanners, copiers, microform machines, workstations and laptops. Many of these tools have recently been installed or updated which has increased the need for operational instructions. Twenty percent of all non-directional questions (10.5 percent of all questions) posed at the research desk are regarding these technologies.[46] The questions range from setting up wireless on one's personal laptop to operating the copy machine. The user-demonstrated need for enhanced instruction justified the inclusion of technology in the QR code pilot. Furthermore, the step-by-step nature of operating a device like a copier lends itself well to textual representation, voice recording, or video, all of which might be communicated through a QR code.

The librarians realized that only a small portion of users approach the research desk; therefore, librarian contact details were chosen as the final component of the pilot. Whether the user is intimidated, unaware of the services available, unmotivated to navigate the library building, or in a location away from the library, QR codes provide a quick method of contact with librarians. A user might choose to call, chat, or e-mail a librarian, and each method could be made possible through a QR code. Emphasizing personal contact would also combat the potential depersonalization of the library research services, which was perceived to be one potential pitfall of QR codes.

QR CODE PLACEMENT

The next implementation step was to determine where QR codes would be placed and displayed. Locations were chosen on the main research floor, in the main circulating stacks (Norlin Stacks), and in the Norlin Commons for the pilot stage of the project. Based on the defined issues (way finding, technical, and contact), there were several sub-locations relevant in each area, for example, wayfinding help in areas near stairways or elevators, technical instruction near copy or print stations, contact help in areas not in close proximity to service points.

The librarians then drafted a poster for each location that included a title, the text 'scan/ capture barcodes with your mobile device,' the libraries' logo, a link to the library chat and contact page, and a link to the Microsoft Tag reader application (see figure 1). The information included on each poster was location specific and labeled as a question the user might pose. For example, the periodical stacks poster included questions such as:

- How do I find older issues of the journal? [map to bound journals and instructions]
- Find the call number for the journal/ magazine I need? [Periodical title look-up]
- Find a scanner? [Map to scanners]
- Find a copy machine? [Map to copy machine]
- Get more help? [Link to chat window]

Other core questions answered by the posters were:

- Where am I?
- Where is: stack location, scanner, printer, computer, help desk?
- How do I: scan, copy, print, add money to my card, get a refund, ask a question?
- Where can I: find study space, check out a book, ask a question, scan, print, find a computer?

A later phase in the pilot extended to locations beyond the library with the purpose of promotion and contact. The posters distributed to locations outside the library had similar components including four QR codes pointing to the research services' chat window, the research services' phone, vcard details for research services, and a map of libraries on campus (see figure 2). The librarians selected a few locations on

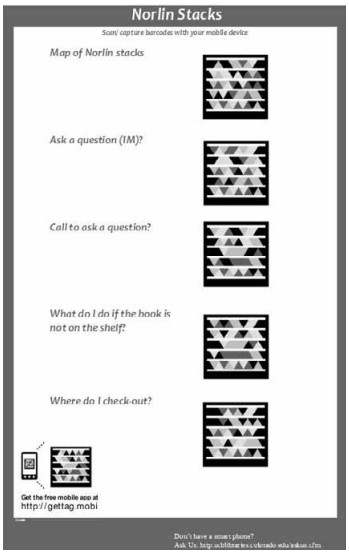

Figure 1. Barcode Poster: Stacks

Figure 2. Barcode Poster: Reference

campus where students often congregated such as the main student center which houses dining areas, classrooms, and computers labs. Poster display was coordinated with campus housing services to distribute posters in student dormitories. Finally, posters were also hung in specific librarian liaison departments. Though the librarians identified a number of places one might distribute posters to connect with students in their own environments, the locations were kept to a minimum for this stage of the project. Furthermore, statistics and analysis of posters hung outside the library were not included in this study due to the more recent implementation.

QR CODE CREATION

The Microsoft Tag interface is easily navigable making the generation of QR codes intuitive. After signing in, the tag manager opens where one may create, edit, and render QR codes. When creating a QR code, one may choose to assign a specific category to which the code belongs. This strategy was employed for all QR codes that would be displayed outside of the library. The advantage of creating categories is the ability to view use statistics in comparison to other categories. Using this capability, the volume of use in campus dorms, in campus communal spaces and in the library could be tracked. Over time, this comparison would be useful in understanding common locales where users experience research needs. Microsoft Tag reports provide data on daily scans, scans by category, and category comparison.

Microsoft Tag provides four types of content that may be associated with a QR code: URL, free text, vcard and dialer. The default content type, URL, will direct a user's mobile device to the mobile browser in which the designated URL will load. In the pilot, URL QR codes pointed primarily to maps, the mobile chat window, and the mobile library catalog. The free text content type allows text up to 1000 characters to be displayed on a user's mobile device. Free text was used in instances when the existing web content was not mobile friendly or did not present in a concise form, for example library hours and simple operational instructions. The third content type, vcard, acts as a digital contact card. Like the contact details sent in e-mail messages, a vcard typically includes name, company, e-mail, phone, fax, address, and URL. Using the tag manager, one may either manually enter these details or upload the vcard file type. A user may then save the information to their contacts or simply note the contact information necessary for their specific need. Vcard information pointed users to CUB's main research services contact information or to specific subject librarian contact information. Finally, the pilot included the dialer content type to facilitate assistance when a user wished to speak directly to a librarian. When selecting a dialer QR code, the mobile device automatically dials the designated phone number.

When creating the QR codes, a naming system was used to clearly designate which codes were associated with specific posters and physical placement. Because many of the posters included maps with customized location detail, the naming system was essential to organize the printing and hanging of posters. This organization would have been aided by creating more categories; however, the librarians did not realize the strength of category creation when initially generating the QR codes. A category may be assigned or added to a QR code at any time, but categories must be established before the QR code creation date. Given this realization, a clearer category tree and organization scheme will be designed for future implementations.

After rendering each QR code, the final posters were printed and displayed in assigned locations. Each QR code was tested using a mobile device to ensure the end content loaded correctly and was associated with the correct poster. This testing relied on the mobile devices owned by members of the Research and Instruction department. Ideally, however, testing would incorporate a variety of mobile devices equipped with various operating systems, browsers, and carriers. The Microsoft Tag Implementation documents strongly encourage such testing in the actual QR code environment.[47]

LESSONS LEARNED

Usage Statistics

To gauge basic understanding of early usage and student reaction to QR codes, the reports function of Microsoft Tag allowed the librarians to pull some preliminary data from the pilot. While the pilot is ongoing, the snapshot of early responses was useful and the first form of feedback. Fifty-six QR codes were created for the pilot project, which were scanned a total of 226 times over 4 months, an average of 4 times each. Although deep analysis of this data was impossible at

this early stage, it was clear that in this first iteration, navigational and help based QR codes were the most used. In terms of navigation, stacks based information formed a group of highly used QR codes. A map of the stacks was the most frequently scanned (35 times), while maps directing patrons from the stacks to the circulation desk (12 times) were also valuable. This tallied well with the hypothesis that QR codes have a significant navigational use as well as corroborating the validity of the aim to connect the virtual (call number) to the physical (stacks map). A second group of frequently used QR codes was the help information. Calling the library (18 times), chatting with the library (14 times) and the library contact details (12 times) were all scanned frequently, which backs up the hypothesis that QR codes can help reconnect librarians and patrons (see table 1). QR codes were scanned frequently throughout the semester. While there was slightly more activity in August and September, it is hard to tell whether this was due to the novelty of the technology, or the usual beginning of semester confusion (see table 2).

The basic conclusions that can be drawn from these preliminary statistics are that although no user education, marketing or outreach took place, library patrons at CUB were curious about these QR codes. An article that appeared in the local newspaper and personal correspondence with the campus community further demonstrated this.[48] QR codes are still relatively unknown though, and the librarians hypothesize that with further user education, there would be a rise in use. Walsh showed that QR promotion increased patron recognition of the codes by 14 percent from 8 percent to 22 percent and the librarians are confident that similar promotion and wider usage would have a similar effect at CUB.[49] Further data analysis is also necessary. In the future, analysis of usage by poster location and poster composition would allow further conclusions about QR code best practices to be drawn.

Challenges

While the QR codes enabled a novel way to meet user needs and to create a conduit between the physical and virtual library, the technology and pilot were not void of challenges. The core challenges can be conceived as broad, global QR access issues and local technical and programmatic support specific to the University of Colorado.

The librarians were acutely aware that while cell phone ownership statistics at CUB are high, there must be members of the campus population who were excluded from this service. Keeping that in mind, the posters and marketing materials included a link to the libraries' *Ask Us* webpage, to which a user might connect manually. Clearly, the process was not as seamless as the QR code enabled access. As the project develops and expands, it will include the exploration of solutions for users without QR code reader devices. Potential solutions could include circulating readers, permanent location specific kiosks (project currently underway at CUB), or pervasive electronic way-finding solutions. Regardless, eliminating the divide to access or establishing alternate communication solutions is a significant challenge warranting further investigation.

Barriers to access extend beyond user ownership of QR code readers. As Farkas notes, despite the potential of QR codes in libraries, "only a small portion of our population will probably take advantage of them until they become more mainstream."[50] Before the pilot, students and campus members may or may not have encountered QR codes in the local newspaper, on campus webpages or in other public media. Furthermore, before implementing the pilot, the librarians did not undertake any usability testing or user education and therefore lacked data about local user awareness of QR codes. Small graphics were included on each pilot poster visually representing that a mobile device could scan QR codes, but this minimal user education could be greatly expanded. Pending institutional support of the pilot's continuation, user awareness studies and user-education campaigns will be pursued to diminish this access issue. Successful user education will also require attention to mobile device updates and preloaded QR code reading capabilities.

Another barrier to user access centers on the placement of posters, both in terms of specific locations, as well as the height of poster or QR code displays. Noting that students can be hesitant to approach the research desk for fear of humiliation in front of their peers, the authors considered user timidity in terms of QR code scanning. Several of the pilot posters were placed around the very busy research floor, and students may have been intimidated to approach a poster for similar reasons. This question could be investigated more fully as posters are placed in both high traffic and low traffic areas. The height and location of posters and QR codes should also be analyzed to ensure accessibility for wheelchair bound and disabled users.

A final consideration for this and for similar QR code implementations is the potential barrier imposed between users and librarians. While the QR codes serve as surrogate help sources, the pilot did not intend to replace human interaction completely. Booth found in her video kiosk project that video kiosks did not "enable a level of personal contact and communication that can vastly enhance the reference interaction."[51] The same shortcoming was present in the QR code pilot. Therefore, future iterations will more strongly encourage in-person help through meetings and consultations. This could be realized through enhanced marketing of online and physical help points.

Other challenges encountered were largely the result of local technical capabilities and the project's sustainability. In this regard, the central challenge faced was working with a non-mobile library website. While the CUB Libraries have since purchased access to Innovative Interfaces's AirPac mobile catalog module, there are currently no plans to implement a mobile site for all other online library content. When designing the QR codes and pointing to information, awareness of the end information's readability on mobile devices was necessary. In some cases this meant that new content

duplicated library website information in favor of simpler text that could be communicated by a QR code.

Similarly, the maps created for the pilot were separate from the main library site and duplicated some existing content. The first reason for creating new maps was because of the homepage's non-mobile friendly nature. Second, the maps designated the user's location and provided customized directions to alternate locations and therefore needed to be designed with the poster location in mind. Like the transition of library webpage content to text, this decision demanded that the librarians be diligent about monitoring changes to library procedure, services, and locations. With any change, the librarians were required to edit the map or textual instruction. With a larger implementation of the pilot, the workload and coordination of manual updates needs to be considered and more graceful edit options explored.

Table 1. Most Popular Scans (Aug.–Nov.)

Barcode Title	Description	Scans
Stacks 1 (Norlin)	I need a map of Norlin Stacks	35
Help (Phone)	Phone the Research Desk	18
Help (Chat)	Chat with a Librarian	14
Study 1	Where can I find Study Spaces?	12
Help (Person)	Research Desk Vcard data	12
Nor Stacks 3 Circ	Map of Stacks to Circulation Desk	12
Libraries 1 Branches	Map of Branches	12

Table 2. Number of Barcode Scans by Month (Aug.-Nov.)

Month	User Scans (all barcodes)	Number of Barcodes Scanned (56 total)
August	38	15
September	28	14
October	24	11
November	27	17

FUTURE CONSIDERATIONS

Extension of the Pilot

As one of the major focuses of the pilot has been the connection of the physical and virtual library, the librarians intend to further examine collection driven QR implementation. Accordingly in Spring 2011, the librarians implemented QR codes more widely in the main and reference stacks. In the main stacks, QR codes with contact details for subject bibliographers were placed in the relevant areas of the stacks as well as near quick catalog look up stations. In the reference stacks, QR codes provided links from physical reference resources to their electronic counterparts. After reducing the number of physical reference materials in the reference stacks in favor of electronic versions, the librarians have found that people accustomed to browsing the reference stacks were unaware of reference material available online. Therefore, signs linking the electronic to the physical material were hung, as well as general signs that provide information about electronic newspapers, dictionaries and biographies among others.

Another major focus of the pilot has been connecting users with public service librarians at the precise point of need. The CUB librarians will continue to investigate methods of meeting this objective through QR codes. Posters marketing research services will continue to be distributed, as will specific subject librarian contact. Opportunities to include contact driven QR codes in various marketing materials, course guides, and handouts will also be explored. As organizational conversations occur, the potential of QR codes to facilitate student needs like study room reservation or viewing classroom calendars warrant examination. As can be observed in this pilot experience, QR code possibilities are endless. Eventually, and as CUB proceeds with the pilot, QR codes should be evaluated as part of the general marketing rather than merely as a tool in itself.

As other creative applications are explored, implementation will be based on user feedback and use analysis. Where and when users find and use QR codes, what other information they would like to see, and their ideas for QR code application will be elicited. Ideally, the librarians will uncover a method to transform the one-way communication enabled by QR codes to a two-way communication in which students could leave and contribute feedback, help, or suggestions.

Broader Implementation

Ideally, QR implementation will extend throughout the library and campus. The pilot experience has identified barriers and has provided the opportunity to consider future changes that will address these concerns. Before broader implementation, user education solutions should be explored and facilitated by organizational conversations. As a new technology, there are varying standards, designs and uses for QR codes and if QR codes are to be useful to users, it is necessary to establish some best practices and concerted user education. Ramsden and Jordan point to the development of a user "information hub" about QR codes as a key factor to the success of similar projects.[52] Digital signage, videos and online guides as well as further staff education within and outside the library could provide instruction about QR codes and their uses. Boise State University has developed an online guide for QR codes, demonstrating one solution to user education.[53] Additionally, as the project expands to include other libraries on campus, the Libraries need to discuss a consistent look and feel for display materials to provide a visual cue for users. Communication and education should also include working with other departments on campus, which would further facilitate QR code usage. An example of this would be creating agreements with campus locations to avoid signage removal.

With all future implementations, the technical sustainability of the project needs additional consideration. Maintenance of both the libraries' mobile and traditional web presence raises questions of scalability, which will require organizational discussions and strategic planning. Ultimately, a commitment to mobile web communications will be required to fuel projects like this one. But through this and future QR code use studies, libraries may gather tangible evidence that will motivate future library mobile web development.

Conclusion

The University at Colorado at Boulder Libraries experience revealed important considerations as well as several benefits to the use of QR codes as an outreach and communication tool in academic libraries. The major benefit observed was the flexibility to reach users in previously disconnected campus and library spaces. Furthermore, with patron-initiated QR code scans, research help could be accessed on a highly individualized point of need basis. QR code content delivered customized help whether in the form of text-based instruction, a visual map, or various contact mechanisms such as phone or chat. Consolidation of research services has often meant less personalized help for users, but QR codes allow librarians to build relevant help accessible when and where users need it. Finally, because help is accessed by a personal mobile device, it can be recorded and stored for later use, meaning that users can remain connected to the library long after the initial QR code scan.

The scope and impact of the mobile web is growing daily, and QR codes are playing an important role in these developments. This study demonstrates the need for further statistical analysis of user awareness, use, and reaction to QR codes. Analysis of trends could be used to direct the content and placement of QR codes while also investigating a number of further research questions posed by this study: What placement and display strategies encourage or discourage QR code use? What QR code user education strategies are most effective? Finally, this study has placed greater emphasis on the need to understand user information seeking habits in multi-device realities. This will prove key to the implementation of QR codes and other mobile projects in the future.

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